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TRANSACTIONS

OF THE

KANSAS

ACADEMY OF SCIENCE.

1873.

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1874.

REPORT OF THE KANSAS ACADEMY OF SCIENCE.

At the last session of the Legislature, the Kansas Academy of Science was incorporated as a State organization by the following act:

"The Academy of Science shall be a co-ordinate department of the State Board of Agriculture, with their office in the agricultural room, where they shall place and keep for public inspection the geological, botanical and other specimens, the same to be under the direction and control of the officers of the said Academy of Science. An annual report of the transactions of said Academy of Science shall be made on or before the fifteenth day of November, of each year, to the State Board of Agriculture, for publication in the Annual Transactions of said Board. This section to be inoperative and void unless accepted by the said Academy of Science, in writing, signed by the president and attested by the secretary thereof." [Chapter 137, Sec. 2.]

The people of the State have thus indicated their appreciation of the aims and work of the Society, by incorporating it as a State institution.

The year has been fruitful to the cause of science in the State, in many respects.

Professor B. F. Mudge, of the State Agricultural College, has discovered, in Osage county, fossil footprints, of which a paper containing a full synopsis is appended. This is probably the most important discovery ever made in science in the State of Kansas, and will add a laurel wreath to the well-earned reputation of this veteran geologist. The discovery has already elicited a wide interest in scientific circles in the East, and several tons of the specimens have been ordered for Eastern cabinets.

Professor Frank H. Snow, of the State University, has continued to publish his carefully prepared meteorological reports, at Lawrence. The University has been provided with a full set of self-registering instruments for meteorological purposes, and there is a good prospect that it will be made a signal station.

Professor J. H. Carruth has continued his observations on the plants of Kansas. He writes in substance:

"I have become acquainted with twenty-one species that I gave last year on the authority of Prof. Snow and Hall. The year past I have studied more the hedge plants and grasses. I have found the garden gooseberry to be *Ribes hirtellum*, native in the country, but not wild in Kansas. My list of plants for the year, which I send, is to be increased by the observations of Prof. Snow, who has added about eighty species. Prof. John Wherrell collected all summer, and will add some; also, Mr. E. A. Papineau. Prof. B. F. Mudge has sent me some specimens, and Mrs. Craig, of Quenemo, has brought me a teasel not in the books. I have found two which Prof. Wood thinks are new, viz.: an Asclepias, one foot high, with a single nodding umbel, and a Rosa, with lone stem quite prickly; leaflets, about nine, and flowers about ten, and fruit mostly conical."

Prof. Wood proposes to name these plants after their discoverer as a recognition of his long and unrewarded service in this department of science. Prof. Carruth has also discovered some undetermined plants which may prove to be new to science. Other members of the Academy have been laboring faithfully in their respective departments, the fruits of which appeared abundantly at the annual meeting.

The need of a more thorough scientific survey of the State is being felt in various ways by the people. The State, for example, possesses the most ample water-powers along its numerous streams for manufacturing purposes. Could these be determined by a competent engineer, and utilized, it would result in an immense annual saving to the State. Science thus applied to the practical affairs of life yields rich returns to any people.

PROCEEDINGS OF THE SOCIETY.

The sixth annual meeting of the Society was held in the University building, at Lawrence, on September 8th and 9th, 1873, and was largely attended by the scientific men of the State. The papers read before the Society were of unusual merit, and the proceedings elicited a very general discussion in the public journals. There was such a pressure of papers and business before the Society, that the President suggested the necessity of resolving it into sections, as is customary in larger scientific associations, so that all the papers presented could be read.

The following transactions of the Society are of public interest:

The subject of auxiliary societies was introduced, discussed and approved, and a committee, composed of F. H. Snow, B. F. Mudge and F. E. Stimpson, was appointed on the same. The Topeka Scientific Institute was admitted as an auxiliary society.

The attention of the Society was called to the subject of standard weights and measures for Kansas, and the following resolution was adopted:

"*Resolved*, That a committee of three be appointed to consider the question of standard weights and measures for the State, and to report some recommendations to the Legislature of the State during the next session—reporting as a committee of this Academy, F. W. Bardwell, F. E. Stimpson, and Robert J. Brown."

The following papers were read:

On the Action of Lime on Soils, by Miss Jennie Detmers.

On traces of the Mound Builders in Kansas, by B. F. Mudge.

On the Meteors between the sixth and the thirteenth of August, by John Fraser.

On Tornadoes, by John D. Parker.

On the Composition of Comets' Tails, by F. W. Bardwell.

On our Public Works, by William Tweeddale.

On the Lepidoptera of Kansas, by F. H. Snow. (This paper was illustrated by a large collection of butterflies and moths, very neatly mounted in trays.)

On Explosive Mixtures, by F. E. Stimpson.

On Fossil Footprints in Osage county, by B. F. Mudge.

On the Coleoptera of Kansas, by Edwin A. Papineau.

On the Climate of Kansas, by F. H. Snow.

The following public lectures were delivered:

On Darwinism, by Peter McVicar, D. D.

On John Dalton, or the Quaker Man of Science, by Charles Reynolds, D. D.

The following officers were elected for the current year:

President—Frank H. Snow.

Vice Presidents—John A. Banfield, John D. Parker.

Secretary—John Wherrell.

Treasurer—Robert J. Brown.

Curators—Frank H. Snow, B. F. Mudge and Edwin A. Papineau.

The following Commissioners were confirmed for the current year:

Geology—B. F. Mudge.

Ornithology—F. H. Snow.

Entomology—F. H. Snow, Edwin A. Papineau.

Language—D. H. Robinson, J. H. Lee.

Engineering—F. W. Bardwell.

Technology—F. E. Stimpson.

Astronomy—John Fraser.

Meteorology—John D. Parker.

Botany—J. H. Carruth, John Wherrell, F. H. Snow.

Mineralogy—W. D. Kedzie.

Chemistry—William H. Saunders.

Society adjourned to meet Monday evening, September 7, 1874, at Topeka.

SYNOPSIS OF PAPERS.

TRACES OF THE MOUND BUILDERS IN KANSAS.

BY BENJAMIN F. MUDGE.

Few traces of the old mound builders are found after passing fifty miles west of the Mississippi river. No mounds have been found in Kansas, and the few traces of their villages are very obscure. The object of this paper is to draw attention to the subject, that others may be induced to notice and record any fact within the bounds of our State which will throw light on the existence of this ancient race.

About half a mile from the crossing of the old Santa Fe trail at Cow creek, in Rice county, are seen the remains of pottery, etc., showing that at least a temporary village formerly existed at that spot. The area covered is small, and the pottery very fragmentary.

In the extreme northeastern corner of Riley county, on a farm, we found fragments of pottery, arrow heads and other stone implements, and also the clippings of stone left where the implements were made. The area covered over twenty acres, and is a very pleasant locality for a small village. There is a fine spring near, and plenty of running water at all seasons in the creek. This locality was drawn to my notice by J. M. Morris, Esq., county treasurer, who presented me with fragments of various utensils collected from the spot.

But the most important locality seen by us in Kansas lies not far from Asher creek, on the southwesterly side of the Solomon river, in Cloud county. The locality is on a rolling prairie, just above the river bottom, which is here quite narrow. The most marked feature of this village is the pottery, where their domestic articles were manufactured. It (the pottery) covers an area from one-fourth to half an acre, rising irregularly at the highest point about two feet above the level of the adjoining prairie, and is composed to a great extent of the materials and debris from the old workshops. In it we found a considerable quantity of the clay dug from the banks of an adjoining ravine, which had never been moulded; some partly moulded, and sometimes mixed with straw, probably to be used in the coarsest articles. Also, fragments from what appeared to be the ovens in which the pottery had been baked. These fragments showed marks of fire, and were too clumsy and coarse to have been part of any household utensil, and were mostly in a heap in the highest and central part of the pottery.

The extent of the village was obscure, as the rank grass covered the ground for long ages, and nearly obliterated all traces of what once existed. That these villages were made by mound builders, appears evident from the appearance of the pottery. Not only is the texture similar, but the ornamental markings are like those described by Foster and others. The peculiar figures seen on the vessel figure 43, page 244, of Foster, are frequently seen. Also, the clearly defined marks as made by moulding the vessel on the inside of baskets. There were "ears" on fragments of the larger vessels, as if designed for bails.

These few traces of the ancient race which preceded our Indians show that the mound builders never visited this region in large numbers, or made very permanent towns. They were probably some of the remote settlements on the outskirts of their civilization, represented by our pioneers, provided our population should cease to extend its advance—a few of their tribes who chose to live where free range of territory was more congenial to their habits than the more densely settled portions of the Mississippi and Ohio valleys, where so many of their large mounds are seen.

RECENT DISCOVERIES OF FOSSIL FOOTPRINTS IN KANSAS.

BY B. F. MUDGE.

About the 1st of July, in crossing Kansas avenue, Topeka, we noticed, on a slab of the flagging, clearly defined footprints of reptiles. There was no hesitancy in referring the stone to the quarries of Crane & Dodd, of Osage. Taking the next train to that place, and carefully examining the quarries, a mile apart, we were well rewarded for our trouble.

The flagging at the new quarry consists of four principal layers, respectively one and a half, two, three, and four inches in thickness, interlaid usually by thin seams of soft shale. The flagging is fine-grained sandstone of close texture, coming out in slabs sometimes ten feet by twenty-five.

At the old quarry, the layers are not so distinct. The slabs, as they are quarried, are frequently inclined to split in thin sheets, some of which are marked by footprints. The best of the smaller ones were thus obtained, giving a fine specimen of footprint and cast.

The deposit is just above the middle of the coal measures, and about a dozen feet above the coal seam worked at Carbondale and Osage. The slabs or layers containing the footprints afford but few fossils, although there are numerous fucoidal impressions with ripple-marks. But immediately above and below the flagging, are calcareous strata containing abundant remains of the usual marine fossils of the period.

We have selected thirty slabs containing footprints, for preservation, there being a few others too poor to pay for removal. Most of these contain but one set of tracks, but several contain two of different species, and one has four sets.

The most common footprints, represented by more than half of all that were found, were large, saurian-like tracks, in character and shape a little like Polemarchus gigans of Hitchcock. It differs in being but two-thirds as large, and in the proportional length of the toe and heel. In our species the toes are all nearly of the same length, five inches, and the heel four inches, making the total length nine inches. The width of the heel is five inches. There are some indications of a fourth short lateral toe. The length of the stride is from twenty to twenty-two inches. Width of the trackway, from center to center of the footprint, is from four to six inches. There are about twenty slabs marked by this species, some of which are very poor. The number of footprints on the slab varies from two to twenty.

The tracks of this species differ much in size, so much so that I was at first inclined to consider them of two species; but I now class them as old and young individuals. On the largest slab, the smaller (there being three rows of tracks) are half the size of the larger, and it will be no great stretch of the imagination to suppose that in this case the mother was followed by her offspring.

Over two hundred footprints of this species were seen, and all found in the four-inch flagging. They are all casts. The outline of the foot in this species is indistinctly defined, rendering its description and indentification very difficult. The reason that no direct footprints were discovered was very apparent. The layer on which the animal walked was a soft clay, which did not harden, but crumbled in removal of the layer above. But the latter being of fine sand and a small trace of lime, took the print of the footstep and hardened to stone. For sidewalks this layer is the most durable, and is in demand where large and firm slabs are desired. In several places on Kansas avenue, Topeka, the slabs show where the raised casts of the footprint have been taken off by the stone-mason to give an even surface. Their relative position can still be easily traced.

Another footprint is that of a smaller animal, the foot measuring by the toes about two inches in length—heel not discovered. Number of toes, four, the fourth being small and obscure. A lateral spur was found in a few instances. Length of the stride, twelve inches, and width of the trackway from center to center, six inches. These tracks were found on six slabs, and on several solitary pieces at three different quarries. Some were also obtained by splitting the larger slabs from the old quarries. The footprint and cast of the same track were, in such cases, obtained. In several instances the lobes of the toes were distinctly seen. The general impression left after a study of this species is, that the animal must have been a clumsy reptile, with some of the traits of both frog and salamander. The number of tracks seen on single slabs varied from one to sixteen. About one hundred and fifty tracks of this species were procured.

The best and most distinctly preserved tracks are those resembling the Cheirothereum. These are found at what is called the "Old Quarry." These tracks are very clear in the outline of the front toes, but the heel is obscure. The outline of the foot appears to have been four and a half to five inches wide, and in length five and a half. The length of the stride is from twenty-one to twenty-two inches. The hind footprint usually covers the heel of the fore foot. We obtained both the true track and the cast. The width of the trackway is eleven and twelve inches, measuring from center to center. The front foot has four toes, the hind foot five, the fifth being short and perhaps rudimentary. The footprint shows that the animal in walking rested his weight mostly on the toes, as these are strongly and clearly impressed, while the heel can be traced with difficulty. In several instances the wrinkle of the skin could be seen. No trace of a claw was visible. In plumpness the toe resembles the Chierotherium, the toes being more divergent. It also resembles the foot of the Saurotus Primevus, found in the sub-carboniferous of Pennsylvania, but is clearly an animal differing from both. We procured twelve slabs of this species, and a few single tracks. From four to sixteen footprints were found on each slab, numbering in all about one hundred.

These footprints are as distinct and clear as the average of those found in the sandstone of the Connecticut valley. They are sufficiently perfect to give the characteristics of the feet of these animals, and their modes of progression, from which they can be reconstructed.

We found also five small tracks somewhat like the above, measuring three-fourths of an inch in length by one and a fourth in breadth. This was not enough to decide the character of the animal.

On one slab are two prints very much like a mule's foot, or, rather, his shoe. A similar mark has twice been described (in Europe and America), as a footprint; but recent investigations have decided that it is the impress of a fucoid or marine plant.

We have here four distinct species, all probably different from those previously discovered, from other parts of the world. They also are valuable from the fact that few footprints are found west of the Alleghany mountains. Their geological position down in the coal measures also adds to their scientific value. We have not given so detailed a description of them as is necessary for identification of species, as some of them will go to Yale College, and there be compared with their large collection, and Prof. Marsh will then proceed to assign their true paleontological character and name them. I have compared them with known footprints of the Connecticut valley, and have been surprised at their apparent resemblance; yet, when we recollect that those are *triassic*, while ours are in the middle of the coal measures, it seems most probable that they are generically distinct, and will add new races to the earliest air-breathing animals of our globe.

REPORT ON THE BOTANY OF KANSAS FOR THE YEAR 1873.

BY J. H. CARRUTH.

During the past year I have devoted what time I could spare from other duties to a further examination of the Plants of Kansas, and herewith give the result. Some cases doubtful last year have been solved, and I have become acquainted with twenty or more of those given last year on the authority of Professors Snow and Hall.

The past year our corps of observers has been much increased. In addition to Prof. Snow, we have had Prof. Wherrell, of Leavenworth; Dr. Saunders, of Lawrence; Mr. Papineau, of Topeka; and Dr. Watson, of Ellis; to whom the proper credits will be given. The latter gentleman has given thirteen, none of which are found in Wood's Class Book or Gray's Manual.

It is sometimes asked, Of what use is botany to a farmer? I have repeatedly known persons to set out wild grape vines, and look two or three years for fruit, when the blossoms had stamens or male organs only, and could never produce fruit. Some grape vines from seed have perfect blossoms; that is, both stamens and pistils, and some have stamens only. But vines from cuttings always have the same kind of blossoms as the vine they were taken from.

A man once set a large garden full of strawberry plants, nearly all of which had pistils, or female organs only. He had plenty of blossoms, but no fruit. By putting a sufficient number of either perfect or staminate plants among them, he might have had fruit.

A lady once cut off the "false blossoms," staminate ones, from her cucumber vines, to make them bear better. She should have known that these were just as necessary as the others. A botanist knows how to keep different varieties of corn, melons, etc., from intermixing and degenerating.

Last summer Dr. Wright, of Penn Yan, New York, wrote me that he had seen in a New York paper a statement that a grass or grasses in Kansas never produced seed. He did not believe it, but wished to know whether I knew of any such grass. I replied that every plant in favorable circumstances produced seed, but if the soil, climate or season were unfavorable, and especially if the plant also produced tubers, it might seldom produce seed. From time immemorial (to me), my father had in his garden a dense thicket of artichokes, helianthus tuberosus. They never blossomed till I cultivated some of them in hills like potatoes. Sweet potatoes seldom or never blossom in this climate, but doubtless they do in their native place. Some varieties of common potatoes seldom or never blossom; others blossom, but produce no seed; while others produce seed abundantly. I have noticed that those varieties which have "balls" have poor, watery potatoes.

A patch of wild rice in a wet basin near Osawatomie sent up no flower stalks for seven years, and then it had them twelve feet high.

The three most common and valuable prairie grasses of Kansas, some years produce only leaves, except in some favored spots.

Buffalo grass, so called in Miami county, seldom or never blossoms, but doubtless it does further west.

Some pear trees and plum trees blossom abundantly, but never bear fruit; probably from a lack of something in the soil that is needed to perfect the fruit.

Plants not in the Class-book nor Manual, are marked thus;* immigrants thus.†

ADDITIONS TO THE CATALOGUE OF THE PLANTS OF KANSAS FOR THE YEAR 1873.

RANUNCULACEAE.

Clematis, Virgin's Bower.

C. Pitcheri. One specimen.

Anemone, Wind Flower.

A. patens or Nuttalliana. Western Kansas. Snow.

Ranunculus, Crowfoot.

R. recurvatus. Lawrence and Leavenworth. Snow.

R. fascicularis. Wakarusa woods. Snow.

NYMPHEACEAE.

Nymphaea, White Water Lily.

N. odorata. Southern Kansas. Prof. Mudge.

FUMARIACEAE.

Corydalis.

C. aurea, variety Flavula. Lawrence. Snow.

C. montana. Lawrence, Snow. Topeka, Papineau.

CRUCIFERAE.

Nasturtium, Water-cress.

N. sylvestre. Lawrence, rare.

Dentaria, Pepper Root.

D. laciniata. Wakarusa.

Cardamine, Bitter Cress.

C. rhomboidea. Leavenworth. Wherrell.

Arabis, Rock-cress.

A. Canadensis. Vinland.

Brassica and Sinapis, Cabbage and Mustard.

† B. arvensis. Field Mustard. Snow.

Lepidium, Peppergrass.

* L. intermedium. Lawrence. Saunders.

Vesicaria, Bladder-pod.

* V. Fendleri. Ellis. Watson.

CAPPARIDACEAE.

Cleome, Spider Flower.

* C. integrifolia. Leavenworth. T. E. Wilcox, U. S. A; also Topeka, Papineau.

VIOLACEAE.

Viola, Violet.

V. sagittata. Lawrence, one specimen. Snow.

CARYOPHYLLACEAE.

Agrostemma, Corn Cockle.

† A. Githago. Topeka. Papineau.

Cerastium, Mouse-ear Chickweed.

C. nutans. Lawrence. Not abundant.

Arenaria, Sandwort.

* A. stricta. Ellis. Watson.

MALVACEAE.

Callirrhoe, Mallow.

* C. involucrata. Salina; also Russell Co. Snow.

Malvastrum.

* M. coccineam. Abundant in Central and Western Kansas. Snow.

GERANIACEAE.

Geranium, Crane's Bill.

G. maculatum. Leavenworth. Wherrell.

BALSAMNACEAE.

Impatiens, Touch-me-not.

I. fulva. Topeka. Papineau.

POLYGALACEAE.

Polygaea, Milkwort.

* P. alba. Ellis. Watson.

LEGUMINOSAE.

Vicia, Vetch.

*V. linearis. Common at Lawrence. Snow.

Lathyrus, Sweet Pea, etc.

*L. linearis. Ellis. Watson.

[Are these two the same?]

Trifoliam, Clover.

T. procumbens. Yellow Clover. Topeka, Papineau.

†T. arvense. Topeka, one specimen. Papineau.

Astragalus, Milk Vetch.

*A. multiflorus. Ellis. Watson.

Oxytrophis.

*O. Lambertii. Western Kansas. Snow.

Glycyrrhiza, Licorice.

*G. lepidota Lawrence. Also sent from Marshall county by W. J. McLaughlin. Abundant in alkali lands. Snow.

Hoffmanseggia.

*H. Jamesii. W. Kansas. Sent by Prof. Mudge.

ROSACEAE.

Pyrus, Apple, etc.

P. angustifolia. Lawrence. Snow. I think I found the same, but could hardly make it agree.

Rosa, Rose.

*R. ————. Lawrence. Referred to last year as a variety. Mr. Wood thinks it distinct. Stem strigous, 18 high; leaflets, mostly, 9; flowers corymbous, about 10; fruit mostly conical.

LYTHRACEAE.

Cuphea, Cuphea.

C. viscosissima. Near Osawatomie.

ONAGRACEAE.

Œnothera, Evening Primrose.

*Œ. lavendulaefolia. Ellis. Watson.

Gaura.

*G. virgata. Lawrence. Snow. Probably the same as G. linifolia given last year from Eaton.

Ludwigia, Bastard Loose-strife.

L. alternifolia. Leavenworth. Wherrell.

L. palustris. Lawrence. Saunders.

Myriophyllum, Water Milfoil.

M. scabratum. Lake four miles from Lawrence.

CACTACEAE.

Opuntia, Prickly Pear.

*O. vulgaris, var. Rafinesquii. Lawrence. Saunders.

SAXIFRAGACEAE.

Heuchera, Alum Root.

H. hispida. Lawrence. Snow. Also Leavenworth. Wherrell.

UMBELLIFERAE.

Cicuta, Water Hemlock.

C. maculata. Lawrence.

Cryptotaenia, Honewort.

C. Canadensis. Lawrence. Snow.

Æthusa. Fool's Parsley.

Æ. cynapium. Lawrence. Snow.

COMPOSITAE.

Liatris.

L. cylindracea. Lawrence. Saunders.

Aster, Aster

A. sagittifolius. Lawrence. Saunders.

Diplopappus, Double-bristled Aster.

*D. ericoides. Ellis. Watson.

Solidago, Golden-rod.

S. virgata. Miami county.

S. speciosa, var. rigidiuscula. Topeka. Papineau.

Heterotheca.

H. scabra. Lawrence, one specimen. Snow.

Eclipta.

E. procumbens, erecta and alba, var. brachypod. Lawrence. Saunders.

Silphium, Rosin-weed.

S. laevigatum. Lawrence. Common.

*S. asperrimum. Lawrence. Snow.

Heliopsis, Ox-eye.

H. laevis. Type of which var. scabra is more common. Lawrence. Saunders.

Echinacea, Purple Cone-flower.

*E. atrorubens. Lawrence. Occasional.

Rudbeckia, Cone-flower.

R. triloba. Lawrence.

R. hirta. Lawrence. Snow.

Lepachis.

*L. pulcherrima, var. of columnaris. Lawrence. Saunders.

Helianthus, Sunflower.

H. trachеliifolius. Lawrence. Saunders.

Gutierezia.

*G. Euthamiae? [T. and A.] Mr. Wood says Genus certain, species doubtful — rag pappus uniformly wanting. He suggests the name G. heteropappus. Roadsides. Eudora and Paola. Fifteen inches high, branching above; flowers bright yellow.

Cirsium, Thistle.

C. Virginianum. Lawrence. Saunders.

Krigia, Dwarf Dandelion.

K. Virginica. Lawrence, one specimen. Snow.

Hieracium, Hawkweed.

H. Gronovii. Lawrence. Snow.

H. paniculatum. Lawrence. Snow.

LOBELIACEAE.

Lobelia, Lobelia.

L. spicata. Topeka, rare. Papineau.

CAMPANULACEAE.

Specularia.

*S. leptocarpa. Lawrence, one specimen. Snow.

PLANTAGINACEAE.

Plantago, Plantain.

P. lanceolata. Lawrence, one place; also Topeka. Papineau.

OROBANCHACEAE.

Conopholis, [Wallroth]; Philipea. [Don.] Squaw Root.

C. Ludoviciana. From W. J. McLaughlin, Marshall Co. Snow.

SCROPHULARIACEAE.

Linaria, Toad-flax.

*L. vulgaris. Road-side, Lawrence.

Pentstemon, Beard-tongue.

P. grandiflorus, Russell Co., abundant. Snow. Also Lawrence. Saunders.

P. pubescens. Various places. The P. Digitalis of last year.

Conobea.

C. multifida. Osawatomie. Also Lawrence. Snow.

Veronica, Speedwell.

V. Anagallis. One place seven miles southwest of Lawrence.

Castilleja, Painted Cup.

*C. pallida. Ellis. Watson.

LABIATAE.

Scutellaria, Scull-cap.

*S. Drummondii. Lawrence, rare. Snow.

S. lateriflora. Sent from Marshall Co. by S. D. Mauk. Snow.

Stachys, Hedge Nettle.

S. palustris. One place five miles east of Lawrence.

S. sylvatica. Lawrence, one specimen. Snow.

[S. sylvatica, Nutt., S. Nuttalliana. Shuttlew.]

BORRAGINACEAE.

Echinospermum, Burr-seed.

*E. Redowskii. Ellis. Watson.

CONVOLVULACEAE.

Cuscuta, Dodder.

C. conuiflora. Lawrence. Saunders.

C. Gronovii. Lawrence, common. Snow.

ASCLEPIADACEAE.

Asclepias, Milkweed.

A. Sullivantii. Wakarusa bottom. More social than other species.

A. Vasegi. One place.

* A. ——— Lawrence. Several specimens. Mr. Wood cannot find its name. Stem slender 2″ diam., 15′ high, pubescent; leaves opposite, lameolate, sessilo, round at base, acute at apex; 2″ long,–10″ wide; umbel one, terminal, *nodding*' peduncle 1′–2′.

ARISTOLOCHIACEAE.

Asarum, Wild Ginger.

A. Virginicum. Lawrence. Woods.

POLYGONACEAE.

Polygonum, Knot Grass, etc.

P. maritimum. Lawrence. Occasional.

CHENOPODIACEAE.

Cycloloma.

* ? C. ———. A specimen was on exhibition at the State Fair from Southwestern Kansas, 2½ ft. broad, and 15 inches high, with a short stem one or two inches in diameter. The leaves had fallen off; the fruit was smaller than on specimens found here.

EUPHORBIACEAE.

Acalypha, Three-seeded Mercury.

A. gracilis. Lawrence. Saunders. A. graciIens, Gr. same as A. Virginica, E. ?

ORTICUCEAE.

Parietaria, Pellitory.

P. Pennsylvanica. Lawrence.

JUGLANDACEAE.

Juglans, Walnut.

J. cinerea, Butternut Lyon county. Papineau.

Carya, Hickory.

C. aquatica. Common. Known by leaflets resembling peach leaves.

C. mitro carpa. Near Osawatomie. The bark is nearly black.

C. ———. Little trees found near Clinton. Leaflets about 9, closely sessile, abovato-lanceolate, and *strongly cordate at base*. If this is the C. amara, this point should be noticed.

CUPULIFERAE.

Quercus, Oak.

Q. falcata, Spanish Oak. Lawrence and Willow Springs.

SAURURACEAE.

Saururus, Lizard-tail.

S. cernuus. Lawrence, one specimen. Snow.

NAIADACEAE.

Najas, Water Nymph.

N. flexilis. Lake four miles north of Lawrence.

Potamogeton, Pond-weed.

P. natans. Lake. The one foretold last year.

P. pectinatus. Lake. All three abundant.

ALISMACEAE.

Sagittaria, Arrow-head.

S. variabilis, var. gracilis, leaves narrow, same lake. Also var. obtusifolia, latifolia and sagitterfolia, very common, distinguished by Dr. Saunders.

Echinodorus.

E. rostratus. Lake, abundant. Snow.

HYDROCHARIDACEAE.

Anacharis, Ditch Moss.

A. Canadensis. Lawrence. Saunders.

AMARYLLIDACEAE.

Hypoxis, Star-grass.

H. filifolia. Topeka. Papineau.

SMILACEAE.

Smilax, Greenbrier.

S. tamnifolia. Lawrence. Snow.

LILIACEAE.

Allium, Onion.

*A. reticulatum. (?) Ellis. Watson.

Pontederiaceae.

Heteranthera.

H. reniformis. Lawrence. Saunders.

Juncaceae.

Juncus, Rush.

J. tenuis. Lawrence; very common.

J. megacephalus, or J. nodosus, var. megacephalus. Lawrence. Common.

J. scirpoides, var. echinatus. Lawrence.

Cyperaceae.

My cyperaceae were mostly examined by Dr. S. H. Wright, of Penn Yan, N. Y. Prof. Snow's are undoubtedly correct.

Cyperus, Galingale.

C. phymatodes. Lawrence.

C. Michauxianus. Lawrence. Saunders.

C. inflexus. Lawrence.

C. inflexus, var. thrice longer. Lawrence.

C. acuminatus. Lawrence.

C. compressus. Lawrence.

Eleocharis, Spiked Rush.

E. palustris. Lawrence.

E. tricostata. Near Eudora.

E. olivacea. Lake.

E. tenuis. Lawrence.

Scirpus, Bulrush.

S. debilis. Lawrence.

S. fluviatilis. Water.

S. polyphyllus. Lawrence, common. Snow.

S. lineatus. Lawrence.

Fimbristylis.

F. spadicea. Lawrence.

Trichelostylis.

T. autumnalis ? Lawrence.

T. capillaris ? Lawrence.

Carex, Sedge.

I give the names as in Wood's Botanist and Florist, and in the order of that book. Where the names given me were different, I give both names.

C. vulpinoidea. Lawrence.

C. stipata. Leavenworth. Wherrell.

C. cephalophora. Lawrence.

C. rosea. Leavenworth. Wherrell.

C. scoparia. Lawrence.

C. cristata. Lawrence.

C. straminea. Lawrence.

C. festucaeea. Lawrence. Snow.

C. adusta. Lawrence.

C. stricta. (acuta), Lawrence. Snow.

C. Davisii. Lawrence.

C. stenolepis. Lawrence. Snow.

C. laxiflora. Lawrence. Snow.

C. granularis. Lawrence.

C. panicea. Lawrence.

C. Meadii. Very common in Eastern Kansas. Snow.

G. Hitchcockiana. Leavenworth. Wherrell

C. lanuginosa. (pellita.) Lawrence. Snow.

C. polymorpha. Lawrence. Snow.

C. riparia. (lacustris.) Lawrence. Snow.

C. ampullacea. (utriculata.) Lawrence. Saunders.

Gramineae—The Grasses.

The gramineae given below were all found near Lawrence, except as otherwise given:

Leersia, False Rice.

L. oryzoides, Cut Grass.

Agrostis, Bent Grass.

A. vulgaris, Red Top.

A. alba, White Bent, Bonnet Grass.

A. elata, Taller Thin Grass.

Sporobolus, Drop-seed Grass.

S. cryptandrus.

Cinna, Sweet Reed Grass.

C. arundinacea. River bank near Osawatomie.

Muhlenbergia, Drop-seed Grass.

M. glomerata.

M. diffusa. Alongside walks and in shady places covering the ground. Leaves very short and nearly at right angles with the stem.

*M. ————. River bank, Osawatomie. Mr. Wood cannot find the name. He thus describes it: "Slender, glabrous, branching, one foot high; panicle erect, capillary, loose, branches in 3s and 5s, whorled. Spikelet scarcely 1″ long, much shorter than their pedicels. *Glumes pointed, rough on the keel, the upper one shorter, but longer than the two equal obtuse 3-veined poles*, which have a few short beards at their base. Comes nearest to M. Mexicana, but is decidedly different by the characters italicized."

Calamagrostis, Reed Bent-grass.

C. Canadensis, Blue Joint. One place Wakarusa bottom.

Paspalum.

P. fluitans. Mostly under water. Osawatomie.

Panicum, Panic Grass.

P. proliferum.

P. agrostoides.

P. viscidum. Snow and Saunders.

Bromus, Brome Grass.

B. secalinus, Chess.

B. mollis, Downy Chess.

B. ciliatus.

Tricuspis.

T. (Wralepis) purpurea.

Dactylis, Orchard Grass.

D. glomerata.

Festuca, Fescue Grass.

F. ovina. Sheep's Fescue.

F. pratensis, Meadow Fescue.

F. elatior.

Eatonia.

E. obtusata.

Melica, Melic Grass.

M. mutica. Scattered, tall, conspicuous.

Eragrostis.

E. reptans. Riverbank, Osawatomie.

E. Purshii.

E. erythrogona. Seen once.

Poa, Spear Grass.

P. compressa.

P. sylvestris. Both have flattened stems.

Glyceria, Manna Grass.

G. nervata.

G. maritima.

Triticum, Wheat.

T. violaceum. Distinct from T. repens or Couch Grass.

Leptochloa.

L. mucronata. Osawatomie.

Eleusine, Yard Grass.

E. Indica. Yard of Presbyterian church, Lawrence.

Buchloe, Buffalo Grass.

* B. dactyloides. Ellis. Watson.

A grass called by this name grows near Osawatomie, but it seldom or never blossoms. so that it would require close observation to determine it. It grows in stools as Buffalo grass is said to, and is of about the same size.

Filices, Ferns.

Polypodium. Polypody.

P. incanum. Burlington. Mrs. J. N. Locke.

Aspidium, Shield Fern.

A. spinulosum, var. Bootii. Lawrence. Saunders.

HEPATICAE.

Marcantxia.

* M. polymorpha. Saunders.

Species added, about 175.

Not east of the Mississippi, about 27.

LAWRENCE, Kas., Dec. 1873.

SPECULATIONS IN REGARD TO COMETS' TAILS.

BY F. W. BARDWELL.

Of all questions in Astronomy pressed conspicuously upon notice, none seem to elude the grasp of the scientist with more subtlety than that of the character and composition of comets' tails. From Copernicus to Newton, from Newton to Le Verrier and to the spectroscopist of to-day, are seen a series of brilliant triumphs. The Ptolemaic epicycles have vanished into the simplest of curves; the multitudinous array of celestial orbs follow each other with infinite precision and never-ending succession, according to laws comprehensible almost by a child. The perturbations of Uranus have responded to the interrogations of Le Verrier and Adams, and our sun and the more distant suns, though they tarry not in their courses at the command of any modern Joshua, yet reveal to the searching gaze of the spectroscopist the secrets of innumerable ages, and declare their common membership of one illimitable system.

Such are the conquests of astronomers; and yet an intruder, as it were, rushes impetuously into the insignificant domain of our own solar system, and, it may be, with a passing nod to Jupiter, whirls angrily around the sun, whose proximity seems to kindle a fiery train, then retreats as suddenly as he appeared, departing with regal courtesy, never turning the back toward the gaze of his august majesty, the Sun, and at his disappearance leaves the ignorant beholder terrified, and the startled philosopher bewildered.

Let us glance briefly at the more important facts, and try to find out their significance. Comets are those bodies moving around our sun in orbits of considerable eccentricities. Perhaps this characteristic is the most decisive of those which serve to distinguish them from other members of our solar system, though the classification may really be empirical. There is, indeed, great diversity in the phenomena attending different comets. Some accomplish their revolutions in three or four years; others in three or four thousand years; others still in a hundred thousand years; and finally, it is thought, some never revisit our solar system. Many comets have tails, so called, while others have none; and still others are surrounded by envelopes of a hazy or misty appearance. Some of the so-called tails have been of remarkable extent, and in general have followed the comets in approaching the sun, and preceded them in going away, attaining their maximum soon after passing perihelion. This it is that has so puzzled astronomers. The nucleus evidently obeys the law of gravity, but in passing perihelion the tail sweeps around contrary to that law, and with a vivacious energy that would laugh gravity to scorn.

It has been suggested that the matter composing the comets' tails differs essentially from that of the nucleus, being of a nebulous character, or at any rate in a nebulous condition; though the exact nature of this character or condition of matter no one could define, but it was thought to be misty-like, or vaporous and extremely rarefied. It was further thought that some repulsive force, emanating in the sun, acted on the nebulous fog of the tail, while it did not act on the nucleus, thus giving to the sun a double-dealing character, blowing hot and blowing cold at the same time, quite at variance with his usual character for consistency. Bessel computed the form and motion of the comets' tails subject to such a repulsive force in the sun; and after him, Pierce. Bessel supposed that the material elements of the tail were developed from the nucleus, flowing away from it and soon lost to it: that is, became separated from it so far that the attraction of the nucleus no longer had an appreciable effect upon them, while the repulsive force of the sun carried them off still further and dissipated them entirely from view. But this hypothesis involves the difficulty of supposing that the same matter which originally formed a part of the nucleus, and as such moved subject to the attractive force of the sun, afterwards becoming evolved from the nucleus, was then repelled by the force of the same sun with an increased energy.

Now a change in the molecular condition of the elements of a body may often develop repulsion among those elements, as for instance, the ignition of powder, or even an increase of temperature, and so we may understand the development of a repelling force whose center is situated within the nucleus; but in Bessel's hypothesis the center of the repellant force is supposed to be in the sun, millions of miles away.

Though Bessel's hypothesis may have given away in the light of more recent investigations, yet a statement of it in this place may help to present in a clearer light the real difficulties in the problem before us. And in looking for all the facts that may have a bearing on the question, let us not forget that the space between the sun and planets, and even that between our solar system and other systems, cannot be absolutely void, for light, whether it come from our sun as the bright harbinger of day, or whether it come in the faint twinkling that reaches us after a tireless flight of centuries, in either case travels along the waves of celestial ether of unbroken continuity. Where the terrestrial atmosphere fades away, or at what limits the solar atmosphere loses itself in the etherial depths, we know not, yet it has been clearly established that flames of meteors become visible in the neighborhood the earth at a much greater distance from the earth than the supposed limits of our atmosphere, these flames apparently resulting from the resistance of the medium through which the meteors pass; and the zodiacal light, evidently a solar phenomenon, indicates the existence of a belt of luminous matter, or of matter that may become luminous, extending around the sun, even outside the earth's orbit.

Next in order may be mentioned the interesting relation recently shown to exist between some of the comets and the periodic meteors. Thus, Tempel's comet of 1865, and the November meteors, are said to have the same orbit; that is to say, the orbits are so nearly identical that they indicate a common origin. In a similar way it is found Tuttle's comet of 1862 moves along in company with the August meteors, and the bright comet of 1861 moves in company with a less conspicuous group of April shower-meteors.

Oppolzer, Peters, Weisse, Le Verrier and others have contributed to these results; but Schiapparelli, of Milan, has been the most active, both in obtaining results and in interpreting them, and his theory is favorably received. Nebulæ is a name given to bodies of cosmical matter in that diffuse condition in which it is supposed the material of the solar system once existed, when it occupied continuously all the space from its center far beyond the limits of Neptune's orbit. Schiapparelli supposes that among such cosmical clouds, floating in space, it occasionally happens that one comes within reach of the sun's attractive influence. The attraction acts more powerfully on the nearer portion, and while the nebula is still at a great distance, it begins to lose its spherical form, becomes elongated and somewhat cylindrical, the foremost part becoming denser and more pointed. As it approaches nearer the sun the transformation becomes more complete, the part nearest the sun becoming a dense nucleus, and the part following forms the tail, curved in consequence of the lateral motion preserved by the nebula during its progress.

Thus we have a comet moving in an orbit whose eccentricity and plane depend upon the initial circumstances. The comet is not, however, a solid mass, but consists of particles, each possessing an independent motion, and the comet becomes more elongated, and at last is resolved into a ring of meteors. In the course of time the matter composing a comet, which completes its revolutions around the sun, must be dispersed over the whole path. Schiapparelli affirms that the comet of 1862, No. III, is simply the remains of the original comet, out of which the meteoric ring of the 10th of August has been formed in the course of time. Le Verrier, adopting this theory, traces the history of the comet of 1866, No. 1, first discovered by Tempel. A cosmical nebulous cloud he thinks entered our system in January, 126, and happening to pass near the planet Uranus was brought by its attraction into an elliptic orbit around the sun. This orbit is that of Tempel's comet, and identical with that of the group of November meteors. He supposes this meteoric cloud became visible as a comet in 1866 for the first time. The tail of this comet is composed of the multitude of small meteoric bodies which follow the nucleus, and as our earth encounters them for three successive years, the tail must have a length of nearly eighteen hundred millions of miles. Such, in brief, is the theory of comets and their tails, as advocated by Schiapparelli and Le Verrier, but it seems to leave the original difficulties, with no diminution of their force.

This theory seems to offer no satisfactory explanation of the mode by which the material elements of the tail are seen first to follow the nucleus; then, near perihelion, to be chiefly outside the orbit; and finally, to be in advance of the nucleus. Spectrum analysis has in a wonderful manner enabled astronomers to penetrate long-hidden secrets; and naturally, this agent has been summoned to aid in the solution of this question. So far, however, the opportunities to make this agent available in the examination of comets have been limited. Donati was the first, in 1864, to study spectroscopically the light of comets; and recently Secchi, Huggins, and others have given their attention to the same object. No brilliant comet has in the meantime appeared; and the results obtained, which chiefly pertain to the nucleus only, though of importance, may be briefly stated. It seems then clearly established by spectrum analysis, that the nucleus of a comet is self-luminous, and that the luminous portion is a glowing gas—in some instances carbon being present. It is also probable that the luminous nucleus may in a slight degree reflect sunlight. Scarcely more than this has yet been determined by means of the spectroscope; but the appearance of any bright comet will be the occasion of the most attentive observations, and we may hope then for a complete solution of this interesting puzzle.

In the meanwhile, waiting thus for the return of such a far-wandering messenger, even now on the way laden with news, we can only indulge in speculations; and I venture to offer some of these that point, it may be, toward a solution—speculations that may subsequently be verified, or subsequently proved to be fallacious.

Allusion has already been made to the zodiacal light, which indicates the existence of a belt of luminous matter, or of matter that may become luminous, extending far out from the sun. The motions of Encke's comet indicate a resisting medium, and let us suppose this granted. In accordance with this hypothesis, observation shows that for the same comet the display of a brighter train occurs, with an increased velocity and diminished distance from the sun, the cumulative effects of which reach a maximum only after perihelion passage. For different comets, so far as other conditions coincide, the same principle is verified.

We have seen, too, that comets and meteors appear in some instances to have a common origin, and that meteors are composed chiefly of elements well known, though it is probable that the more volatile elements become entirely separated in passing through our atmosphere from the more solid portion which actually reaches the surface of the earth.

Let us suppose, then, that we have merely a larger mass of meteoric matter, possessing in its composition some elements capable of volatilization, moving in such an orbit as any of the comets are observed to have; then, with the exception of the tail, all the phenomena of a comet would naturally follow, according to the different circumstances supposed. Entering the resisting medium, more or less heat would be developed, according to the velocity, which would increase as the mass approaches the perihelion, while the resistance and heat would increase still more rapidly, attaining a maximum soon after passing that point. The heat thus developed and probably increased by the proximity of the sun, would tend to volatilize some of the elements of the body, causing them to become luminous and present the phenomena of the corna and the nucleus. It is possible, too, that some of the elements of the medium through which the body is moving would share in and increase the luminosity.

Now, with regard to the tail, it has been heretofore assumed that the train so designated, often accompanying a comet, is an essential part of it. Bessel thought, as we have seen, that the material elements of the tail were derived from the nucleus flowing from it, and then repelled by a force centered in the sun. Schiapparrelli and Le Verrier think these elements are of the same kind of substance as that of the nucleus, but in a more diffuse condition, and becoming luminous by some motion among themselves.

But may it not be possible that this train of light which accompanies a comet, and has been called a tail, is, in fact, no part of the comet more than a shadow is a part of the object which gives it form? May it not consist of particles of the medium through which the comet passes, made luminous by the rays of the sunlight acted on by the glowing gas of the corna? If the zodiacal belt forms this medium, in whole or in part, being already slightly luminous, its luminosity (it is possible to imagine) might be easily increased.

How the phenomenon of light is actually produced, we do not know. We know that the flames of certain gases give rise to it—that is, cause the necessary undulations of the ether, and we know that our sun is the source of a large supply of light, and, though we may know some of the attendant circumstances in these cases, yet who can tell the circumstances that give rise to auroral light, or who can tell the origin of zodiacal light?

So we may see the phenomenon of light in the train that accompanies the comet, and, though we may not be sure of all the conditions that take place, yet it seems highly improbable that this luminous mist forms any part of the comet, and I predict that when a brilliant comet gives an opportunity to apply the tests of spectrum analysis, it will appear that this bright train is not nebulous, as Bessel thought, and is not diffuse meteoric matter, as Schiapparelli and Le Verrier have supposed, but is the illumination of the medium through which the comet is passing.

In closing, let us notice several facts that have interest in this connection:

It was thought highly probable that the earth passed through a portion of the tail of the bright comet of 1861, on the 30th of June, of that year. The effect was apparently to dim slightly the light of the sun, before sunset, and at the same time to give the sky an "auroral, glare-like look." The comet itself, in the evening, had a more hazy appearance than at any other time after that evening. These incidents seem inconsistent with the theory of a meteoric composition of the tail, but more consistent with the hypothesis of a luminous shadow formed by but not a part of the comet. In 1807, and again in 1811, Chladni, a careful observer, noticed what he styled a prodigious ebullition proceeding from the nucleus to the extremity of the tail of a comet, in a few seconds of time. The tail of the comet of 1811 was estimated to extend four millions of leagues, and light itself travels no faster. It was as if the waves of ether were made visible in their undulations.

A few words with regard to the resistance of a medium, and I close. Only the orbits of short-period comets have been determined with any approach to accuracy; and of these, Encke's has the least perihelion distance. This comet, too, has a shortening of its period, apparently in consequence of the resistance of the medium through which it passes. Is it not probable, too, that such a resistance is the explanation of some of the irregularities of the comets of long period? Thus the comet of 1264 and 1556 was expected to return in 1848. May it not be that the comet of 1843 was the identical one with its period shortened? The comet of 1843 passed very near the sun; nearer even than Encke's comet. Arago made a study of the records of Halley's comet, to determine if possible whether in its successive reappearances it had lost any of its brilliancy. He thought it had lost nothing. May not this again be due to the probable fact that in successive returns the comet approaches nearer the sun, encounters more and more of the resistance of the medium, and therefore tends to develop more fully the phenomena of the tail, which would otherwise be less developed, because the nucleus must be losing some of its volatile elements?

Thus questions of interest press upon us, and astronomy, though the oldest of the sciences, is ever opening new and attractive fields of study.

METEOROLOGICAL SUMMARY FOR THE YEAR 1873.

PROF. F. H. SNOW'S ANNUAL REPORT AS METEOROLOGIST TO THE STATE BOARD OF AGRICULTURE.

Station, Lawrence, Kansas. Latitude 38°, 58′; longitude 95°, 16′. Elevation of barometer and thermometers, 884 feet above the sea level and 14 feet above the ground; rain gauge on the ground; anemometer 105 feet above the ground, on the dome of the University building.

TEMPERATURE.

Mean temperature of the year 52.71°, which is 0.17° lower than the mean temperature of the five preceding years. Notwithstanding this very near approximation of the mean yearly temperature to the mean of past years, the range of temperature was much greater than in any previous year of our record, amounting to 130°. The extremes were 26° below zero January 29, and 104° above zero August 29 and 30. These extremes were respectively 8° lower and 1° higher than any indications of former years. Mean temperature at 7 A. M., 46.15°; at 2 P. M., 61.80°; at 9 P. M., 50.18°.

Mean temperature of the winter months, 26.75° (2.46° below the average); of the spring, 52.10° (1.62° below the average); of the summer, 78.06° (2° above the average); of the autumn, 53.37° (1.28° above the average).

The coldest month of the year, also the coldest month on our record, was January, with mean temperature 18.61°; the coldest week was January 23–29, mean temperature only 2.60° above zero; the coldest day was January 28, with mean temperature 13° below zero. The night of January 28–29 was excessively cold, the mean of seven observations taken at intervals during the night being 22.5° below zero.

The hottest month of the year was August, with mean temperature 79.38°; the hottest week was August 25–31, mean temperature 86.34°; the hottest day was August 30, mean temperature 89.3°.

The mercury fell below zero on nine days—January 9, 10, 17, 18, 24, 28, 29, and February 1 and 2.

There were 48 days on which the mercury reached or exceeded 90°, viz.: 9 in June, 12 in July, 24 in August, and 3 in September. The mercury reached or exceeded 100° on 10 days, all of which were in August. Seven of these days were consecutive, the last seven days of the month, this continuation of intense heat being unprecedented since the record began.

The last frost of spring was April 25, this being a severe frost. The first light frost of autumn was September 8, giving a period of 136 days entirely without frost. The first severe frost of autumn was delayed until October 23, making the period of absence from severe frost 181 days. The excessive cold of the winter killed nearly every peach bud in Douglas county and a large proportion of peach trees over four or five years old. The severe frost of April 25 killed some pear, cherry and plum buds which were just coming into blossom, but left enough buds uninjured to secure an abundant crop.

RAIN.

The entire amount of rain, including melted snow, was 32.94 inches, which exceeds the rainfall of 1872 by 0.31 inch, but is less than the average rainfall of the five preceding years by 1.69 inches. Either rain or snow fell on 101 days—two less than the average number. The longest interval without rain during the growing season, March 1 to October 1, was twelve days, from July 18 to 29. The number of thunder showers was only 17; in 1872 there were 40. There was a marked peculiarity in the distribution of rain this year, giving a great excess to April, May and December, and a great deficiency to July and August. This irregularity of distribution resulted in an exceptionally abundant harvest of wheat and early potatoes, and a light yield of corn and late potatoes.

SNOW.

The entire depth of snow was 26½ inches, distributed as follows: January, 16 inches; February, 3 inches; March, 2 inches; April, 2 inches; December, 3½ inches. The last snow of spring was on April 15; the first autumn snow was on October 27, not enough in the latter case to whiten the ground. The annual amount of snow, as given above, is 4.90 inches above the average for the five preceding years.

FACE OF THE SKY.

Average cloudiness of the year, 42.46 per cent. of the sky, which is 3.77 per cent less than the average. The number of clear days (less than one-third cloudy) was 173; half-clear days (between one-third and two-thirds cloudy), 91; cloudy days, 101. There were 37 days without a cloud, and 29 days without a trace of sky, 10 of the latter being in December. There was not one entirely cloudy day from May 15 to November 1. August was the clearest month—mean cloudiness, 23.87 per cent.; December was the cloudiest month, the mean being 61.50 per cent. The mean cloudiness at 7 A. M. was 47.15 per cent.; at 2 P. M., 46.47 per cent.; at 9 P. M., 33.75 per cent.

DIRECTION OF WIND.

During the year (three observations daily), the wind was from the northwest 261 times; southwest, 218 times; south, 153 times; southeast, 142 times; northeast, 105 times; north, 88 times; east, 72 times; west, 35 times; calm, 21 times. The south winds (including southeast, south and southwest) outnumbered the north winds (including northeast, north and northwest) in the ratio of 513 to 454.

VELOCITY OF WIND.

The number of miles traveled by the wind was 154,508. This gives a mean daily velocity of 423.31 miles and a mean hourly velocity of 17.63 miles, the latter being 6.63 miles above the mean hourly velocity at Philadelphia. The position of the anemometer cups at an elevation of 105 feet above the ground, the most elevated point for full fifty miles in all directions, secures exposure to the full force of the wind. The maximum velocity was attained June 27, when in 22½ minutes the instrument registered 31½ miles, or at the rate of 85 miles an hour. The greatest daily velocity was 1,502 miles, November 18. The strongest winds were in March, April and November; the lightest were in July and August.

BAROMETER.

Mean height of barometer column, 29.093 inches. Mean at 7 A. M., 29.114 inches; at 2 P. M., 29.071 inches; at 9 P. M., 29.093 inches. Maximum height, 29.727 inches, at 2 P. M., February 1; minimum, 28.533 inches, at 9 P. M. April 3; yearly range, 1.194 inches. The highest monthly mean was in December, 29.199 inches; the lowest was in May, 28.947 inches. The barometer observations are corrected for temperature, but not for elevation, in accordance with the rules of the Smithsonian Institution.

RELATIVE HUMIDITY.

Mean for the year, 64.06; at 7 A. M., 75.14; at 2 P. M., 45.77; at 9 P. M., 71.28.

The dampest month was December, humidity 76.38; the driest month was March, humidity 52.88. On the 28th, 29th and 30th of March the air was exceedingly dry, the percentage of moisture at 2 P. M. on the latter date sinking to 3.8, or less than one twenty-fifth of the amount required for saturation. There were only six fogs during the year.

FORCE OF VAPOR (IN INCHES.)

Mean for the year 0.308; at 7 A. M. 0.302; at 2 P. M. 0.300; at 9 P. M. 0.321; greatest, 0.983 at 2 P. M. July 5; least, 0.012 at 7 A. M. January 29; highest monthly mean in June, 0.619; lowest in January, 0.091.

The following table gives the mean temperature, the extremes of temperature, relative humidity, and rainfall for each month of the year 1873; also a comparison with preceding years:

Months.	*Mean Temperature...*	*Maximum Temperature......*	*Minimum Temperature......*	*Relative Humidity.*	*Rainfall in Inches.....*
January	18.61	46.5	—26.0	75.57	2.66
February	30.26	62.0	—6.5	68.15	0.86
March	42.81	74.0	4.0	52.88	1.34
April	48.85	88.0	26.0	63.44	4.42
May	64.64	88.5	46.0	68.93	7.12
June	76.90	97.0	58.0	68.04	2.96
July	77.90	97.0	62.5	64.36	2.38
August	79.38	104.0	56.0	57.87	0.90
September	66.25	94.0	36.0	59.96	3.75
October	51.23	83.0	16.5	57.83	0.92
November	42.58	78.0	12.0	55.40	1.24
December	31.37	67.5	9.0	76.38	4.39
Year 1873	52.71	104.0	—26.0	64.06	32.94
Year 1872	51.90	97.0	—18.0	64.40	32.63
Year 1871	54.30	103.0	—6.0	....	33.23
Year 1870	54.50	102.0	—10.0	68.40	31 38
Year 1869	50.36	96.0	—5.0	....	38.51
Year 1868	53.36	101.0	—16.5	....	37.42